MAP GQ-1667

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC MAP OF THE TWO OCEAN PASS QUADRANGLE, YELLOWSTONE NATIONAL PARK AND VICINITY, WYOMING

By H.W. Smedes, J.W. M'Gonigle, and H.J. Prostka

SMEDES AND OTHERS—GEOLOGY, TWO OCEAN PASS QUAD., YELLOWSTONE NATIONAL PARK, WYO. 1:62,500 MAP GQ-1667

GEOLOGIC QUADRANGLE MAP
Published by the U.S. Geological Survey, 1989

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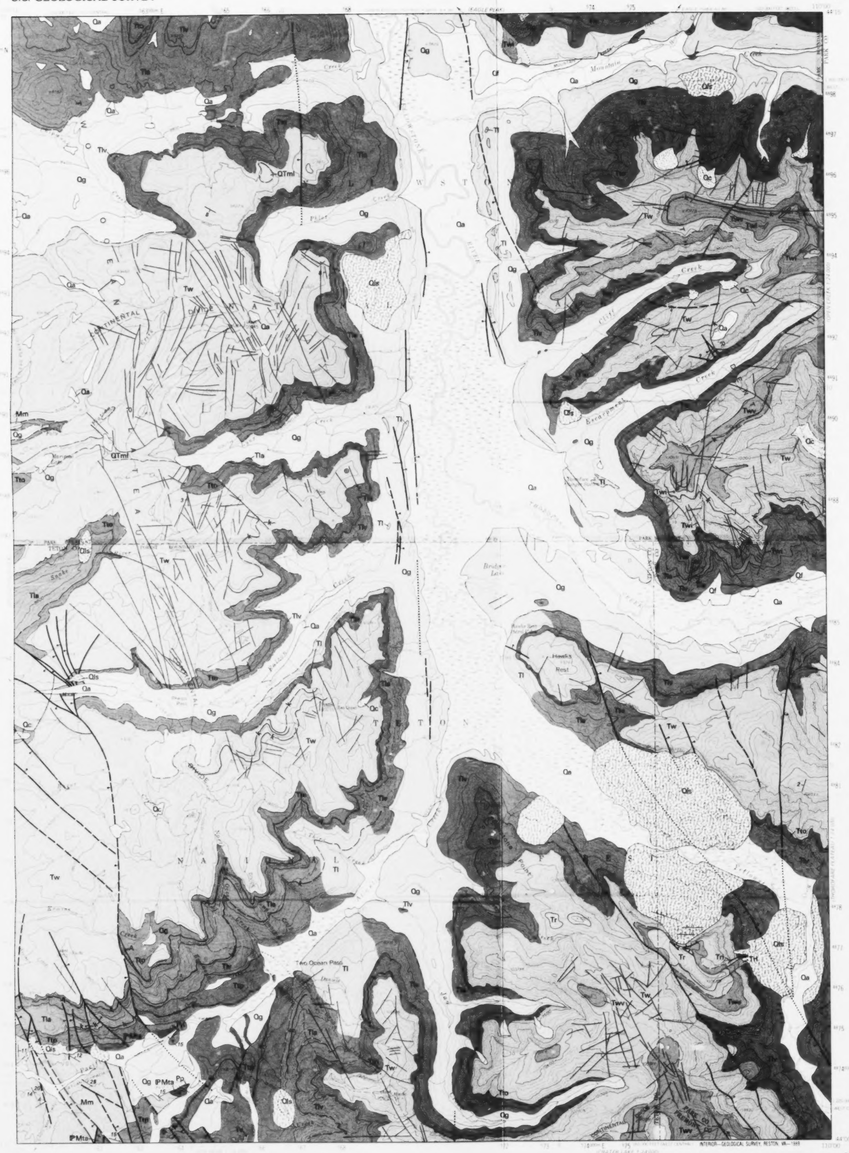


Base from U.S. Geological Survey, 1959
10,000-foot grid based on Wyoming coordinate system, west and west central zones
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

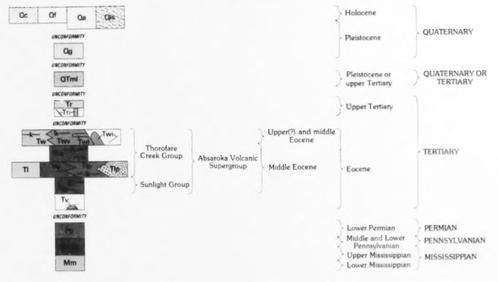
SCALE 1:62 500

CONTOUR INTERVAL 80 FEET
DOTTED LINES REPRESENT 40-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped in 1967–68. Two Ocean Plateau north of Lyna Creek was mapped by H.J. Prostka in 1967. The Trident by H.W. Smedes in 1968, and the remainder of the quadrangle by H.W. Smedes and J.W. M'Gonigle, assisted by A.C. Smedes and R.W. Smedes, in 1968. Surficial geology modified in part from mapping in 1986 by G.M. Richmond and K.L. Pierce (Richmond and Pierce, 1971)

Manuscript approved for publication, January 20, 1988

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Surficial geology modified in part from Richmond and Pierce (1971). Tertiary volcanic units are described more fully in Smedes and Prostka (1972) and prevolcanic units in Love and Keefer (1975)]

Qc **Colluvial, talus, and avalanche deposits (Holocene)**—Unconsolidated, generally coarse, angular debris; deposited by solifluction, rockfalls, or debris flows

Qf **Alluvial-fan deposits (Holocene)**—Unconsolidated, coarse to fine, poorly sorted

Qa **Alluvial and glaciofluvial deposits (Holocene and Pleistocene)**—Unconsolidated, coarse to fine, moderately well sorted and moderately well bedded stream-channel and overbank, glacial outwash, and stream-laid ice-contact deposits

Qls **Landslide deposits (Holocene and Pleistocene)**—Unconsolidated, poorly sorted deposits that have hummocky, generally bouldery surfaces. The deposit north of Pacific Creek probably was an earth flow or mudflow. The landslides along the upper Yellowstone River are large and forested, and consist of kame gravelly sand containing large masses of rock in upper parts that slumped from headwall cliffs

Qg **Glacial deposits (Pleistocene)**—Till and glacial rubble that generally lack distinct morainal form; unit includes kame deposits and, locally, glaciolacustrine clay and silt

QTml **Basalt of Mariposa Lake (Pleistocene or upper Tertiary)**—Medium-gray, dense basalt lava flows that filled an old valley cut into the Wiggins and Two Ocean Formations on the northern part of the Two Ocean Plateau; the flows also occur as two small remnants on the ridge between Badger and Phlox Creeks. The lavas are here interpreted as predating the Lava Creek Tuff (K-Ar age 600,000 yrs—Christiansen and Blank, 1972, p. 9), because no Lava Creek is preserved beneath the basalt. Thickness 0–50 m (0–165 ft)

Rhyolite of Yellowstone Point (Upper Tertiary)—Closely resembles the Pliocene and Miocene Caldwell Canyon Volcanics (Love, 1939) 12 km (7.6 mi) east-southeast of quadrangle

Tr **Rhyolite porphyry lava flows**—Dark- and brownish-gray, aphanitic lava containing conspicuous phenocrysts of quartz; light-tan ash bed occurs above basal flow. On upland surface southeast of Yellowstone Point. At least four individual flows are preserved; total thickness is nearly 150 m (500 ft)

Tr **Rhyolite porphyry dike**—Merges upward into the rhyolite porphyry lava flows (Tr) and is presumed to be a feeder conduit for them

Absaroka Volcanic Supergroup (Eocene)—Includes the Thorofare Creek Group (Wiggins, Two Ocean, and Langford Formations) and the Sunlight Group (Trout Peak Trachyandesite). Calc-alkaline andesitic and dacitic extrusive rocks and lesser amounts of potassic alkalic mafic lavas and a few associated rhyodacitic ash-flow tuffs. Small bodies of intrusive rocks contemporaneous with the extrusive rocks are mapped as part of the formation to which they are petrographically and, presumably, genetically related. The rocks are designated as being of either vent or alluvial facies depending upon their environment of deposition as determined by rock type, grain size, bedding characteristics, and other features described in detail by Smedes and Prostka (1972, p. C4–C8). Alluvial-facies deposits are the chronostratigraphic equivalents of the vent-facies deposits from which they were largely derived. Some units such as volcanic mudflows (lahars) may occur both in vent and alluvial environments. Key beds (k, A, R) were mapped locally to illustrate intraformational unconformity, overlapping, or direction of thinning within formation

Tw **Wiggins Formation (upper? and middle Eocene)**—Andesitic volcaniclastic rocks of vent and alluvial facies and subordinate lava flows. Phenocrysts in the clasts and lava flows are biotite and hornblende, hornblende, pyroxene, and hornblende and pyroxene; plagioclase generally occurs as phenocrysts, although some rocks have mafic minerals only. Principally composed of beds of light-olive-gray mudflow breccia and conglomerate (lahars) as thick as 75 m (250 ft); interbedded fluvial, medium-gray, coarse-grained andesitic sandstone and conglomerate; and thin beds and lenses of very light gray and white airfall pumice and ash, in places reworked and admixed with andesitic silt and sand. Ash beds abruptly increase in frequency and thickness southward from the upper reaches of Jay Creek (near south edge of quadrangle). The upper part of the formation contains several distinctive units of vent-facies rocks (Twv) and lava flows (Twl), mapped to determine changes of facies and nature of intraformational erosional unconformities, some of which are channels as deep as 35 m (115 ft), which separate many beds. Top not preserved; maximum remnant thickness about 500 m (1,600 ft)

k
Twv **Vent-facies rocks**—Composition as described above. Rock types include crudely bedded, unsorted, thick units of agglomerate and other coarse, rubbly breccias; lava-flow breccias chaotically intermingled with agglomerate and mudflow conglomerate. Mudflow and lava-flow breccia contain dispersed lava pods and, in places, pillow lavas

k
Twl **Lava flows**—Distinctive sequence of as many as three complexly overlapping flows of amygdaloidal andesitic lava near the summit of The Trident, in northeastern part of quadrangle, which extend several miles to the northeast at about 10,800-ft elevation where they are overlain by >260 m (>850 ft) of mudflows and other volcaniclastic rocks indistinguishable from those below the lavas. Total thickness about 75 m (250 ft)

Intrusive rocks—Hornblende and pyroxene-hornblende andesite in dikes as wide as 6 m (20 ft) on the south flank of The Trident, as small plugs of andesite breccia just northwest of the dikes, and in a large pluton near the mouth of Mountain Creek (near north edge of quadrangle). The rocks resemble many of the clasts in the mudflows and flow breccias of the Wiggins Formation. Narrow zones of baked rock extend outward from the dikes for a distance of about twice the dike width. In these zones, the clasts of the host-rock breccia or conglomerate are etched by weathering to form concavities; in contrast the clasts in nonmetamorphosed host rocks form knobs

Two Ocean Formation (middle Eocene)—Dark-colored, andesitic volcaniclastic rocks dominantly of the coarse alluvial facies. Mainly coarse, poorly sorted and crudely bedded sheet and channel-fill deposits of conglomerate that form conspicuous cliffs and ledges above the more-subdued slopes of the Langford Formation (Tl). The clasts are cobbles and boulders of subvitreous to dull, porphyritic andesite containing phenocrysts of hornblende or pyroxene, or both, plagioclase, and sparse biotite. Clasts embedded in a matrix of sand, silt, and ash. Locally, sparse, dark-colored vent-facies flow breccias, mudflows, and agglomerate occur at top and base. Between Jay Creek and Two Ocean Creek the unit contains four conspicuous light-colored ash beds. Base of formation is an erosional unconformity having as much as 160 m (520 ft) of relief. The formation is absent locally, as on the south flank of The Trident. Top of formation is an erosional unconformity having as much as 30 m (100 ft) of relief and, as a result, a key ash bed (A), in the middle of the formation in southwestern part of quadrangle, is missing in places. Beyond southeast edge of quadrangle, the Two Ocean Formation loses its identity as it grades into lighter colored vent-facies deposits that resemble the Wiggins Formation, and as it loses its characteristic ledge form. Maximum thickness about 185 m (600 ft)

A
Ash bed—Alluvial-facies, very light gray, water-laid ash that grades upward into airfall ash composed of chunk pumice which is rich in biotite dated as 47.9±1.3 Ma on sanidine and 48.5±1.3 Ma on biotite (J.D. Obradovich, in Smedes and Prostka, 1972, p. C29). In places, the bed is entirely airfall ash containing sparse lithic lapilli. Occurs near middle of formation. Thickness as much as 5 m (15 ft)

k
Tl **Key bed**

Langford Formation (lower middle Eocene)—Andesitic vent-facies and epiclastic alluvial-facies deposits; dominantly light colored. Exposed section is as thick as 370 m (1,200 ft) near the mouth of Phlox Creek, where it consists entirely of alluvial-facies rocks; formation thins to about 80 m (245 ft) by onlap onto pre-volcanic strata near southwest corner of quadrangle

Vent-facies deposits—Light- to medium-gray tuff, brown andesitic laharic breccias, autoclastic flow breccias, thin discontinuous andesite lava flows, and tuff breccias, all variably altered to shades of red, purple, and yellowish gray. Rocks have primary dips of as much as 40°, and form part of a composite, deeply eroded andesitic volcano complex centered north and northeast of quadrangle. Vent-facies rocks compose the entire exposed section of the Langford Formation in eastern half of quadrangle except for small areas at Hawks Rest and in the lower reaches of Jay Creek. Overprint pattern indicates area where unit has undergone low-grade metamorphism adjacent to pluton (Twv) at north edge of quadrangle. Thickness as much as 250 m (800 ft)

Tp **Alluvial-facies deposits**—Light- to medium-gray, well-sorted, thin-bedded to massive, epiclastic volcanic breccia, conglomerate, and sandstone consisting of dark-gray, subangular to subround clasts of pyroxene andesite and hornblende andesite in a light- to medium-gray, ash-rich matrix. The alluvial facies was formed by erosion and redeposition of rocks of the vent facies (Tv), as described by Smedes and Prostka (1972). In western half of quadrangle the alluvial facies is dominant, but grades into and interfingers with rocks of the vent facies (Tv). In that area it generally occurs as a unit about 120–140 m (365–425 ft) thick at the top of the Langford, and in irregularly distributed zones lower in the section. In places, the upper alluvial unit closely resembles the overlying beds of the Two Ocean Formation (Tto). Thickness at least 365 m (1,200 ft) near the mouth of Phlox Creek and 120 m (400 ft) near southwest corner of quadrangle

k
Tp **Key bed**

Promontory Member—Dark-colored, massive bed of conglomerate of alluvial facies. Occurs only along north edge of quadrangle on the east wall of the Yellowstone River valley. North of quadrangle it makes up one of four eastward-thinning tongues interbedded with the more-typical light-colored strata of the Langford. These tongues are interpreted as extensions of the original depositional unit which lay to the northwest but which is now buried by rhyolites of the Yellowstone Plateau. Entire unit in quadrangle has undergone low-grade metamorphism in proximity to pluton (Twv). Thickness about 18 m (60 ft)

Trout Peak Trachyandesite (middle Eocene)—As mapped includes Pacific Creek Tuff Member and lava flows and flow breccias. The Pacific Creek Tuff Member and the lava flows and flow breccias pinch out about 100 m (about 300 ft) west of quadrangle over a prevolcanic topographic high on the Madison Limestone but occur as outliers 2.7–3.5 km (1.7–2.2 mi) farther west

Pacific Creek Tuff Member—Pale-brown to yellow, poorly resistant, partly welded rhyodacite ash-flow tuff containing abundant phenocrysts of sanidine or orthoclase and biotite, fragments of andesite, and broken crystals of labradorite and augite derived from older rocks, all in a groundmass of glass or devitrified glass. Called trachytic rhyolite by J.P. Iddings (in Hague and others, 1899, p. 325). The member discontinuously overlies lava flows and flow breccias that form the main part of the Trout Peak Trachyandesite owing to intravolcanic erosion. The member is partly mantled by glacial till and interbedded locally with the uppermost Trout Peak lavas north of quadrangle. The K-Ar age of biotite from a sample of the Pacific Creek Tuff Member at the type area 1.9 km (1.18 mi) east and 2.83 km (1.76 mi) north of southwest corner of quadrangle, low in the cliffs on the north side of Pacific Creek at an elevation of 8,400 ft, is 48.0±1.3 Ma (J.D. Obradovich, in Smedes and Prostka, 1972, p. C27). Locally, the thickness of the Pacific Creek Tuff Member is as much as 25 m (80 ft), but generally its thickness is <1 m (<3 ft) or it is absent

Lava flows and flow breccias—Gray to dark-gray, dark-greenish-gray, and reddish-brown lava flows and rubbly flow breccias of shoshonite and absarokite (trachyandesite). Flows are dominantly massive and columnar jointed to blocky. Lava contains large phenocrysts of augite and smaller olivine in a dense to sugary textured groundmass containing abundant potassium feldspar. Sparse rubbly flow breccias occur between some flows. The upper half of the unit is characterized by some flows that contain abundant phenocrysts and clusters of phenocrysts of labradorite resembling the rhomb porphyries of the Oslo region in Norway. The feldspathic lavas have vesicular zones and scoriaceous tops, both of which are deuterically altered and crumbly. Thickness 12–270 m (40–900 ft)

Lava flow of rhomb-porphyry type—Single flow at least 12 m (40 ft) thick mantled with a discontinuous veneer of the Pacific Creek Tuff Member. Base of flow mapped to delineate structure in this part of quadrangle

Tv **Volcaniclastic rocks of uncertain correlation (Eocene)**—Medium- to dark-gray and light-olive-gray, poorly sorted, andesitic siltstone and sandstone of alluvial facies. Unit poorly exposed in several small patches along south edge of quadrangle where it appears to be interbedded with the lower part of the Trout Peak Trachyandesite, but more extensive exposures just south of quadrangle demonstrate that these strata lie beneath the Trout Peak. The unit may be a lateral equivalent of part of either the Aycross Formation (middle Eocene) or the Wapiti Formation (middle Eocene), which crops out 80 km (50 mi) to the northeast (Antweiler and others, 1989, pl. 1). Regional relations suggest that the source of the volcaniclastic rocks was to the north and northeast. These strata pinch out a few miles south of quadrangle by onlap onto the pre-volcanic surface. Maximum thickness about 150 m (500 ft)

R
Phosphoria Formation (Lower Permian)—Tan and light-gray chert, lesser amounts of cherty and phosphatic sandstone, and local thin beds of tan, medium-grained sandstone. Probably is the Tosi Chert Member but may also include the Retort Phosphatic Shale Member inasmuch as that member grades into the Tosi in this general area (Sheldon, 1963, p. 91). Prevolcanic erosion removed the Phosphoria toward the west edge of the quadrangle. Preserved thickness 0–52 m (1–170 ft)

Tensleep Sandstone and Amsden Formation—Total thickness approximately 73 m (250 ft)

Tensleep Sandstone (Middle Pennsylvanian)—Light-gray to pale-reddish-gray and rusty looking, massive, medium- to fine-grained, well-rounded sandstone. Weathers as large, subround blocks; also includes sparse, thin limestone, dolomite, and chert. Sparse ripple marks

Amsden Formation (Middle and Lower Pennsylvanian and Upper Mississippian)—Thin, red limestone containing reddish-orange chert, interbedded with tan, yellow, and red limestone; tan and red sandstone, siltstone, and shale, gray, thick-bedded dolomite, and sparse thin beds of reddish-brown and tan quartzite. Locally admixed with Madison Limestone in breccias that probably represent sink-hole deposits

Mm **Madison Limestone (Upper and Lower Mississippian)**—Massive to thick-bedded, gray and tan, crystalline limestone containing local chert and thin laminated zones and a few thin beds of gray quartzite. Upper part contains sponge spicules, brachiopods (spinifers), and oolites. Beds commonly are 2–3 m (6–10 ft) or more thick. Rocks are brecciated and in some places pervasively shattered; clasts may be rotated. The shattering and the thick-bedded to massive form commonly make it impossible to determine bedding attitudes. The lower part is exposed only near west edge of quadrangle where thin-bedded limestones occur as small, sharp ledges and strike ridges etched by glaciation; this part contrasts strongly with the upper part, which erodes to broad, round knolls and irregular discontinuous oval ridges. The upper part locally contains limestone blocks embedded in red siltstone matrix. In the quadrangle, and southward for 1 km (0.6 mi) to Enos Lake, the Madison is hummocky and discontinuously exposed. The surface probably represents a karst terrane on the Madison that was filled by talus derived from the Madison and basal Amsden strata. The surface was subsequently modified by glaciation. Preserved thickness in southwest corner of quadrangle at least 300 m (1,000 ft); base not exposed

Contact—Dashed where approximately located; dotted where concealed

High-angle fault—Dashed where approximately located; dotted where concealed; queried where inferred. Bar and ball on downthrown side

Strike and dip of beds and dikes

Inclined

Horizontal

Landslide scarp—In landslide on south side of upper Yellowstone River

Fractures in bedrock—Formed in the Wiggins Formation (Tw) and rhyolite porphyry lava flows (Tr) in headwall of large landslide on south side of upper Yellowstone River, due to oversteepening. Systematic widening of the fractures results in toppling of the pulled-away block, which breaks up and forms coarse rubble at the head of the landslide deposit. In places fractures are >5 m (>16 ft) wide and >24 m (>80 ft) deep

Lineaments—Pronounced narrow linear and curvilinear features observed in the field or interpreted from aerial photographs; consist of miniature topographic scarps or troughs and conspicuous alignments of vegetation or of bare rock—the alignments are not related to bedding. Represent prominent extensive joints etched by erosion, faults having offsets of less than about 3 m (10 ft), and dikes(?). Judging by relations elsewhere in the Absaroka volcanic field, many are possibly related to emplacement of shallow intrusive bodies not yet exhumed by erosion

GEOLOGIC QUADRANGLE MAP
TWO OCEAN PASS QUADRANGLE, WYOMING
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GENERAL STRUCTURE

The prevolcanic rocks in the southwest corner of the quadrangle lie along the north limb of a northwest-trending anticline of the partly exhumed ancient Washakie Range. They dip about 15° northeasterly and are unconformably overlain by rocks of the Eocene Absaroka Volcanic Supergroup.

A few high-angle faults cut the rocks in the quadrangle. Most of these faults have displacements of less than 35 m (<115 ft). Faults that displace surficial deposits along the walls of the Yellowstone River valley are interpreted as resulting from the latest movement along a fault zone that bounds a bedrock graben beneath the valley.

Except for these faults, the structure of the volcanic rocks is that of irregular warps whose culminations and depressions are probably the result principally of vertical magmatic forces. This structure is demonstrated by the relief on the base of the Two Ocean Formation, excluding the graben of the Yellowstone River valley, which is only 365 m (1,200 ft), the maximum local relief over a distance of 1 km (0.6 mi) is only about 240 m (785 ft). All dips are less than 12°. The base of the Two Ocean Formation was chosen as a structural datum because that formation is composed of sheets of alluvial deposits laid down on a bevelled surface on the underlying vent-facies deposits of the Langford Formation. In the quadrangle, which lies mainly south of the southern flank of a large dome centered around Sylvan Pass 24 km (15 mi) to the north, the base of the Two Ocean is at an altitude of 8,400–9,600 ft. At the summit of that dome, the projected base of the Two Ocean Formation is above 11,000 ft. The north rim of the Trident Plateau, near the north edge of the Two Ocean Pass quadrangle, marks the regional south edge of the dome. However, because of its subdued nature and the fact that the dome lies mostly to the north, the general form of the warped domal surface is not apparent from the geologic map.

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INDEX MAP OF YELLOWSTONE NATIONAL PARK SHOWING LOCATION OF 15-MINUTE QUADRANGLES AND MAJOR STRUCTURAL FEATURES

EXPLANATION

Normal fault—Bar and ball on downthrown side

Thrust fault—Sawteeth on upper plate

Outline of dome

Approximate topographic rim of caldera—Dotted where buried

W — West Thumb caldera rim—Caldera formed by collapse resulting from eruption of tuff of Bluff Point

ML — Mallard Lake dome—Dome formed by magmatic resurgence beneath Yellowstone caldera

SC — Sour Creek dome—Dome formed by magmatic resurgence beneath Yellowstone caldera

Y — Yellowstone caldera rim—Caldera formed by collapse resulting from eruptions of Lava Creek Tuff

R S B — Reid Mountains, Snake River, and Big Bend Ridge caldera rim segments—Remnants of a caldera formed by collapse resulting from eruptions of Huckleberry Ridge Tuff

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